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EUROPEAN STUDY MISSION

REPORT

TO THE

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., June 3, 1983.

To All Members, Committee on Science and Technology:

There is transmitted herewith the Committee report on the European oversight activities which were conducted by Members and key staff of aeronautics, space, science, energy and transportation research and development areas. The review was designed to give Members of the Committee a better working familiarity with the accomplishments and the challenges of our European allies for those areas falling within the jurisdiction of the Committee on Science and Technology.

I commend the report to your attention.

Sincerely,

DON FUQUA, *Chairman.*

LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., June 3, 1983.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology, U.S. House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: I am sending you this report on the study mission to France and Switzerland conducted between May 27 and June 1, 1983. The report includes summaries and discussions of each meeting and facility visit conducted by Members and staff.

On your instructions, the Committee developed a plan to conduct a review of as many aeronautics, space, energy, science, and transportation facilities as time permitted. The schedule was designed to give Members and staff a firsthand opportunity to assess the status and performance of our European allies in technology development, space development and applications, aeronautics, and in the area of high energy physics programs.

Sincerely,

J. H. POORE,
Executive Director.

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FRANCE - COUNTRY TEAM BRIEFING

Location: U.S. Ambassador's Residence, Paris, France
Date: May 27, 1983

SUMMARY

The delegation was briefed by the following staff members of the U.S. Embassy on the subjects indicated:

Mr. Jack J. Maresca, Deputy Chief of Mission
Mr. Michael Ely, Minister -Counselor for Economic Affairs
Mr. John Boright, Counselor for Scientific Affairs
Mr. James Fall, Treasury Attache
Ms. Avis Bohlen, Political Counselor
Brig. Gen. Christian Patte, Defense/Army Attache

HIGHLIGHTS OF BRIEFING

Mr. Maresca: Forty-five agencies of the U.S. Government are represented in France, making this an extremely important and complex mission in which security is of considerable importance.

Recent student demonstrations are rooted in economic conditions and have political implications. The fall labor union elections will also be of great political importance.

Mr. Ely, on Economics: Three topics were touched upon in the briefings; Philosophical, Industrial Policy, and the Williamsburg Summit.

France is managed from the top down because of its small and manageable size and because individual leaders of great energy are able to be very influential. This in in contrast to the U.S. philosophy of setting conditions so that the country can run itself. All banks, transportation systems and ulitilies have been nationalized, and credit is allocated with rates of interest set by the government.

The industrial policy is based on a series of nationalizations. Research and development efforts have been coordinated with the banking system in an effort to make France the third strongest country in technology. However, because of too many projects with high priority this goal is not being achieved.

The Williamsburg Summit is taking place as the U.S. economic recovery is progressing. The French analysis of the world economy, which attributes many world economic ills for the U.S. debt levels and interest rates, is not widely subscribed to by others. The U.S. advances the goal of convergent international economic policies.

Mr. John Boright, on Science Policy: French leaders believe that the future of their country is in high technology and the reasoning tracks that of most states and cities in the U.S. that are pinning their economic hopes on high technology industry. France has been investing about 1 1/2% of the GNP in research and development, is currently at about 2% and has set a goal of 2 1/2%.

Government initiatives are advancing well but certain industrial programs are not. The French are doing some things very well, e.g., mobilizing developments and markets, and basic science. France now has an energy surplus which will increase further as the Super Phoenix Breeder Reactor goes on-line next year.

Among the problems France must overcome are an inmobility of people from the university to industry, twelve weeks vacations, and the transfer of scientific capabilities into products. As an example of a program that has not gone well for the French one may cite the electronics and computer industry, an example in which the government market was not adequate to carry the program.

Recent research and development budgets show a real growth of 18% (including the military's 35% share). The changes in top government officials is viewed as basic politics and not a signal of change in R&D policy.

France's nuclear program has made steady progress; 40% of the electricity is nuclear power and this level will go to 60% as the plants under construction come on-line.

Mr. James Fall, Treasury Attache: France is facing its first economic downturn since the war. The economic program looks gloomy and the gloom appears to be necessary because of the two year program which requires reinflation followed by an austere program including forced savings and expenditure controls. France has faced three currency devaluations, has a foreign trade deficit and too high inflation.

Ms. Bohlen, Political and Foreign Policy: The primary concern of the austerity program is to minimize unemployment, but the program is not popular. Students, farmers and small shop keepers are demonstrating against the government policy. France is outspoken on the East-West security issue (Pershing and Cruse) and the East-West imbalance. They are also very concerned about trends in Germany. There is a broad concensus on security, with only a minor pacifist faction. France will continue its unilateral defense policy.

General Patte, on Defense: NATO maintains very good cooperation, including field exercies, so that whenever a political decision is made to enter NATO, France will be operationally prepared. France has a small nuclear force of 150 warheads plus 48 in submarines. There is some strength to be derived from the fact that this force is totally independent of U.S. and NATO control.

France has conscription .or all 18 year olds, has no foreign troops stationed there, and has committed 4% of the GNP to defense for the next five years. A weakness is the lack of a strategic air lift capability.

A major question is whether France would employ tactical nuclear weapons. There is a philosophical debate over the concept of "escalated response".

THIRTY-FIFTH SALON INTERNATIONAL DE L'AERONAUTIQUE ET DE L'ESPACE

Location: Le Bourget Airport, Paris, France
Date of Visit: May 27 to June 1, 1983

SUMMARY

There were 95 exhibition stands posted in the U. S. Pavilion and approximately another 30 U.S. exhibitors in the main hall. At the U.S. Pavilion the NASA Space Shuttle exhibit drew considerable attention. The Enterprise/B-747 static display and flight demonstration, the Quiet Short Haul Research Aircraft (QSRA), and the Northrop F-20 established a very strong American presence and, in fact, "stole the show". The French presence was, of course, major and right up front including the Mirage 3NG whose flight demonstrations were a main air show attraction.

The Soviet Union withdrew all of their aircraft from the show but had a very impressive spacecraft hardware exhibit in their pavilion. Eastern block nations had only token displays, the most visible was Poland.

There were 800 exhibitors representing 29 countries, 650,000 square feet of covered exhibit space, 32 company chalets, about 50 daily flight demonstrations, hundreds of static display aircraft, a large ultra-light aircraft display, and many technical symposia.

DISCUSSION

Since its inception in 1909, the "Paris Air Show", a biennial event organized by GROUPMENT DES INDUSTRIES FRANCAISES AERONAUTIC ET SPATIALES, continues its traditional role as the world's foremost exhibiton for the international aerospace industry. Truly international in character, the Paris Air Show provides a technical and commercial forum featuring the latest and most sophisticated aerospace technological equipment and services for a constantly growing international audience. Much international trading is initiated at the Paris Air Show.

The U.S. Pavilion was opened on May 27 by President Mitterrand of France. Ceremonies dedicating it to the AIR AND SPACE BICENTENNIAL were conducted that day by Senator John Tower, President Reagan's representative, and the Honorable Hans Mark, Deputy Administrator for NASA.

The NASA exhibit theme was the Space Shuttle and its wide variety of potential applications. This was the highlight of the American Pavilion and many of the commercial exhibitors displayed their companies' span of technology that supports the reusable spacecraft.

The FAA exhibit drew attention to the National Airspace System (NAS) plan for Air Traffic Control (ATC) and a broad spectrum of industry supporting products and technology were displayed.

Of the U.S. aircraft at the show, each demonstrated its own unique characteristics. The Boeing 767 was the quietest for its size. The QSRA was quiet and spectacular in its use of restricted ground and air space. The Northrop F-20 flight demonstration undoubtedly drew the most admiration amongst fighter aircraft. The Enterprise/B-747 combination, without question, was the hit of the show. The daily flights around Paris were impres-

sive and widely heralded in the Paris and international press.

In the exhibit halls the Common Market Countries and Spain showed tremendous industrial technical depth and dominated the action and attention of the involved visitors. Engines, processes, and electronic exhibits were exceptionally competitive.

Emphasis on space seemed to be less than at Paris Air Shows in the recent past. The Japanese were not much in evidence at any level. Brazil's efforts were ambitious considering the relative small size of its aircraft industry. West Germany, with the Dornier and MTU industries were aggressive. Italy used their ATR-42 (roll out in 1984) as a theme but had many tooling, process, and component structure exhibits demonstrating their participation with all aerospace industrial nations.

The Netherlands' family of "Friendship" aircraft and their component level exhibits were impressive. The Spanish, led by CASA, were very visible on the flight line and in the exhibit halls.

Next to Aerospatiale and the many French companies, the British Aerospace Corporation and supporting British and Canadian manufacturers were the strongest exhibitors at the show in almost every product line. The BAe-146 was the quietest commercial aircraft at the show along with the Canadair "Challenger" in its class.

The U.S. was perhaps the third most prominent exhibitor (next to France and the U.K.) with industrial products. The U.S. aerospace industry exceeds its nearest competitors by an order of magnitude but that was not evident at the Paris Air Show except for the Space Shuttle presence.

The several daily publications, and some of the general publications about the Paris Air Show are on file and available at the Transportation, Aviation, and Materials Subcommittee office.

NAVSTAR GLOBAL POSITIONING SYSTEM DEMONSTRATION

Location: On board a Rockwell International Sabreliner 65
Le Bourget Airport, Paris, France
Date: Saturday, May 28, 1983

SUMMARY

Three members of the congressional delegation took a flight demonstration of the NAVSTAR GPS which permits navigation without reliance on ground based navigation systems.

DISCUSSION

Hon. Norman Mineta, Chairman of the Aviation Subcommittee of the Public Works Committee, Rob Ketcham and Scott Crossfield of the Science and Technology Committee staff witnessed a flight demonstration of the Navstar Global Positioning System aboard the Rockwell International Sabreliner that accomplished the first transatlantic crossing with such a system on the previous day.

A one hour flight was made demonstrating the precision of a military and civil system in navigating the Sabreliner utilizing the partially completed Navstar satellite array. The system had been used exclusively to navigate from Cedar Rapids, Iowa, to Le Bourget, and concluded the flight with a claimed 10 meter accuracy at Le Bourget.

The demonstration was in the Paris area and return to Le Bourget, with a repeat of its use to taxi and park the aircraft. The NAA had officials present to verify the claimed records.

SNECMA JET ENGINE ASSEMBLY PLANT

Location: Villaroche, France
Date: May 30, 1983

SUMMARY

The delegation visited the Villaroche Center of SNECMA, the final assembly plant for jet engines that are jointly produced with G.E.

DISCUSSION

SNECMA was established following World War II when the French saw the need for a concerted effort to provide for their national security in the critical area of aircraft engine technology. At that time, several smaller firms were nationalized and consolidated to form SNECMA. At present, the French government owns 66% of SNECMA stock; but, according to company officials, it is otherwise run like a private company. For example, SNECMA managers have never been political appointments from the government. Other groups with representation on the board include the employees with three board members and a variety of private interests. Among these, at one time, was Pratt & Whitney Division of United Technologies, although Pratt & Whitney's share has fallen recently to about 6%, too low for board representation.

SNECMA employment is about 12,000 currently. Of these, approximately 20% are professional engineers or managers. There are three main plants located throughout France. North of Paris, at Gonnevilliers, is SNECMA's forging and casting plant. In the U. S., forging and casting are done by subcontractors, such as Wyman Gordon. In France, however, the overall market for forgings and castings is quite small; so, companies such as SNECMA find it necessary to have their own capability. At Corbeil are the principal manufacturing, design and engineering facilities. The assembly plant at Villaroche employs about 4,300.

The SNECMA product line has included a variety of military and civil aircraft engines. For many years, the mainstay was the ATAR family which have powered the Mirage fighter line. These engines were roughly comparable to the Pratt & Whitney J-79. More recently, SNECMA introduced the M-53 line which power the latest Mirage, the 2000. The M-53 is a low, by-pass ratio (less than one to one) turbofan. The ATAR was a straight turbojet. Other engines developed and produced by SNECMA include the Larzac which powers the Franco-German Alphajet trainer; the Tyne, a turboprop; and the Olympus for the Concorde.

On the civil subsonic transport side, SNECMA is in partnership with G.E. This arrangement began in 1971 when the Europeans were attempting to form a consortium to develop and produce a European airplane. At that time, SNECMA hoped to team with its shareholder, Pratt & Whitney, to produce an engine for the new airplane. Pratt & Whitney, however, was not enthusiastic about the prospects of that airplane -- ultimately known as Airbus. So, SNECMA turned to G.E. which was highly enthusiastic.

The result was an agreement to co-produce the CF 6-50 and later the CF 6-80 for the Airbus. These engines incorporate a by-pass ratio of 6 to 1, which results in noise levels that are lower and fuel specifics that are better than older, low by-pass ratio engines.

Later, in an effort to apply this technology to a smaller, 20,000 pound engine, G.E. and SNECMA joined in a risk sharing venture called CFM 56. G.E.'s responsibility in this project was the core (compressor, combustor and high pressure turbine), while SNECMA agreed to develop and produce the fan and low pressure turbines. Each partner was to receive a share of any profits in accordance with its investment.

Inasmuch as the core that G.E. proposed to use had been developed for use in the B-1 bomber, the U. S. government imposed a number of restrictions to avoid having the engine sold to a third party who might be a potential adversary. Other precautions were taken to prevent U. S. technology from being transferred. Thus, the completed CFM 56 core is shipped to Villaroche where it is mated to the French-built front and back ends without any need to know about its internal details.

Currently there are three versions of the engine. The CFM 56-2 is being produced to re-engine the DC-8 and 300 of the U. S. Air Force's KC 135 tankers. The CFM 56-3 will be used on the Boeing 737-300. This engine is scheduled for certification in the U. S. in September 1983. The CFM 56-4 is the proposed engine for the Airbus A-320, a single isle, 150-passenger transport that is still awaiting orders before production can be started.

The delegation toured the assembly floor which is exceptionally clean and modern. Production rates are 10 CF 6 engines per month. All of these are being sold to Airbus. SNECMA produces 27%, by volume, of these engines; 10% is contributed by MTU in Germany and the rest by G.E. Production of the CFM 56 is currently 17 modules (SNECMA portion of the engine) and 8 complete engines. The remaining 9 engines are assembled in the U. S.

The delegation visited a facility used for abusive testing of the fan and nose cone. It is a vacuum test chamber with a 500 kw motor to turn the fan and a high pressure gun for shooting objects at the fan. Testing includes small and large birds, tire treads, hail stones and ice slabs. The facility is also used to test the effect of a blade separation. This is a very severe condition which usually results in loss of engine power. It must not, however, cause loss of the engine from the aircraft or penetration of the fuselage by fragments. High speed cameras and strain guages are used to record the results.

EUROPEAN SPACE AGENCY (ESA)

Location: Paris, France
Date: May 30, 1983

SUMMARY

The delegation visited the European Space Agency Headquarters for discussions with the Director General and other senior agency officials. The visit included briefings by the European Space Agency on ESA's current programs as well as ESA's views on cooperation with NASA in the future.

The following conclusions emerged from the discussions:

- NASA and ESA relations have improved in the past two years as the lapse of time has softened the strained feelings resulting from the United States unilateral cancellation of the U.S. spacecraft planned as part of the International Solar Polar Mission.
- Future ESA and NASA cooperative science and applications programs will likely involve more coordination of independent programs which could be successful based on the individual merits of each as opposed to past cooperative programs which have involved a high degree of interdependence for success.
- The European Space Agency is very much interested in participating in the NASA space station development if the United States decides to proceed with such a program.

Background

The European Space Agency is comprised of eleven member nations including: Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Additionally, Austria, Canada, and Norway have "observer" status. The fiscal year 1983 budget is approximately $800 million.

In addition to ESA Headquarters the ESA facilities include the following:

- ESTEC (European Space Research and Technology Center) at Nordwijk, the Netherlands--has comprehensive space environmental test capability, manages spacecraft development projects, and conducts applied technology research.
- ESOC (European Space Operations Center) at Darmstadt, FRG, operates ESA satellites and interfaces with NASA tracking network.
- ESTRACK (European Tracking and Data Acquisition Network) has stations in Belgium, Germany, Norway and the Falkland Islands.

- ESRIN (Europen Space Research Institute) at Frascati, Italy, houses ESA's Information Retrieval System.

Other organizational details include the following:

- ESA Council: the major decision-making and policy body which determines the general scientific, technical and administrative policies; approves the annual program; and adopts the annual budget.
- Program Boards: specialized, decision-making bodies that report to the Council. Separate boards for meteorological satellites, Spacelab, Ariane, remote sensing, communications satellites, and space science.
- ESA Directorate: Consists of a Director-General and six Directors.
- Key Personnel:
  - Chairman of the ESA Council: Prof. Hubert Curien (France)
  - Director-General: Mr. Erik Quistgaard
  - Director of Administration: Mr. George Van Reeth
  - Director of Scientific programs: Dr. Roger Bonnet
  - Director of Applications programs: Mr. Edmund S. Mallet
  - Director of Space Transportation Systems: Mr. Michel Bignier
  - Director of ESOC: Mr. Reinhold Steiner
  - Technical Director (and Director of ESTEC): Prof. Massimo Trella
  - Staff--ESA Total: 1400 (ESTEC, 800; ESOC, 300; HQ, 200)

DISCUSSION

Launch Activity: A scientific satellite, EXOSAT, was recently successfully launched for ESA by NASA using a Delta launch vehicle. The EXOSAT is a three-axis stabilized satellite to measure the position, structural features and spectral and temporal characteristics of cosmic X-ray sources.

The next launch of Ariane, the European expendable launch vehicles is schedule for June 16, 1983.

The first flight of the Shuttle/Spacelab is scheduled for September 30, 1983. Final decisions on this mission await the outcome of ongoing on-orbit maneuvers to position the TDRSS in its proper orbit and the successful checkout and on-orbit operation of TDRSS. Although the first Shuttle/Spacelab mission was planned for the use of two TDRSS satellites, more than seventy percent of the mission objectives can be accomplished using only one TDRSS satellite.

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Present Science and Ongoing Programs: ESA'S scientific program has an annual budget of approximately $100 million. The two major discipline thrusts are astronomy and the study of space between the earth and the sun. In addition to EXOSAT which was already discussed, three other scientific programs are underway including the Giotto program, the Hippareos program, and the Infrared Space Observatory.

The Giotto program involves a spin-stabilized spacecraft for flyby and observation of Comet Halley in early 1986. It will include an imaging system and will be launched by Ariane in 1985 into a ballistic trajectory for intercept of the Comet.

Hipparcos is a space astrometry mission for accurate measurement of the triganometric parallaxes, proper motions, and positions of about 100,000 selected stars, most of which are brighter than magnitude 10. The three-axis stabilized spacecraft is planned for launch into a geostatonary orbit by Ariane in 1988.

The Infrared Space Observatory (ISO) was recently selected as ESA's next science project for infrared photometry and spectroscopy of galactic and extragalactic sources. ISO will include a 60 cm cryogenically-cooled telescope and other instruments on a planned 1800 kg, three-axis stabilized spacecraft launched by Ariane late in this decade. This is a follow-on to the Infrared Astronomy Satellite, a cooperative mission between the United States, the Netherlands, and the United Kingdom.

Major science programs being undertaken on a cooperative basis with NASA include the Space Telescope program and the International Solar Polar Mission.

Under a 1977 agreement, ESA is providing a Faint Object Camera, the solar array, and post-launch operational support for the Space Telescope program. In return, European astronomers will receive approximately 15 percent of the Space Telescope viewing time.

With regard to the International Solar Polar Mission, NASA and ESA originally each planned to supply one spacecraft for a two-spacecraft, stereoscopic mission over the solar poles. In February 1981, NASA informed ESA that the U.S. spacecraft would be cancelled due to budget cuts. The European spacecraft will be launched by Shuttle in early 1986 towards Jupiter and will be deflected by Jovian gravity out of the solar system's ecliptic plane with passage several years later over the northern and southern hemispheres of the Sun. NASA's participation is now limited primarily to providing the launch system and providing tracking and data acquisition support through the Deep Space Network.

Application Programs: The major ongoing applications programs include the Meteosat, the European Communications System, the Maritime European Communications System, and the L-SAT.

Meteosat, ESA's first Geostationary European Meteorological Satellite, was launched on a reimbursable basis by NASA in November 1977 for the world-wide GARP (Global Atmospheric Research Program) effort. The spacecraft returned good imagery. Meteosat-II was launched on the third Ariane test launch in June 1981, and is now operational. Recently, Europe established "Eumetsat" to operate current and future meteorological satellites.

The European Communicatios Satellite (ECS) will be the basis for an operational European regional satellite system which meets combined European radio television and post/telecommunications requirements. The ECS is to be launched by Ariane on its next mission (L-6, planned for June 1983).

ESA offered to launch two Maritime European Communications System (MARECS) spacecraft for the International Maritime Satellite (Inmarsat) organization. The first MARECS spacecraft was launched on Ariane in December 1981. The second was destroyed as a result of the Ariane L-5 failure in September 1982. MARECS-B2 is waiting assignment to a future Ariane mission.

L-SAT is a large spacecraft platform planned for Ariane launch in 1986 for a variety of communications missions, including possibly an operational demonstration of direct TV broadcast and an experiment in 20/30 Ghz communications.

Ariane Launch Vehicle: Ariane is an independent European capability for operational launch of up to 850kg geostationary satellites beginning in early 1982. (1750kg payloads into transfer orbit.) The first launch in December 1979 was successful. The second launch in May 1980 was unsuccessful. The third test launch in June 1981 and fourth test launch in December 1981 were successful. Ariane was declared operational in early 1982, but the first operational launch in September 1982 was not successful due to a turbopump failure in the third stage. The sixth launch of Ariane is scheduled for June 1983. ESA directed the development program while CNES, the French national space agency, is the technical manager. NASA is providing telemetry and tracking support on a reimbursable basis. The future operational launches will be conducted by Arianespace, a French corporation with CNES as the major shareholder.

Spacelab: Spacelab is a multi-purpose, manned space laboratory for use with the Space Shuttle, for which ESA is funding $900-plus million development costs under a 1973 NASA/ESA Memorandum of Understanding. Development by European industry team led by ERNO of the Federal Republic of Germany. The engineering model was delivered to NASA in December 1980 and the first flight unit was delivered in December 1981. The second flight unit is being purchased by NASA from ESA (cost approximately $260 million, including spares and the second instrument pointing system) and will be delivered in 1983-85. As discussed earlier, the first Shuttle/Spacelab launch is planned for September 30, 1983, pending successful on-orbit checkout and operation of the TDRSS satellite.

Space Station and Platforms: ESA has undertaken a study on space station mission analysis and architecture as part of their STS Long Term Preparatory Program, which also includes studies on Ariane Upgrades and an all-European space station.

There are two aspects of the ESA study: (1) European utilization of a space station and (2) potential European participation in space station (for example, Spacelab-derived elements; Eureca or other European space project-derived elements; and new areas such as solar arrays, an orbital transfer vehicle hangar, and an orbital propulsion system based on Galileo retropropulsion module).

ESA plans to present the major study results of their efforts to NASA Headquarters in mid-June.

FUTURE SCIENCE MISSION

ESA officials stated that the following five proposed programs were being further evaluated with a view to considering them as possible candidate missions in the Agency's Scientific Program for the late 1980's and early 1990's.

- FIRST - Far Infrared and Sub-millimetre Space Telescope.
- XMM - X-Ray Space Observatory (Complementary to the United States advanced X-ray Astronomy Facility).
- AGORA - Asteroid Rendez-vous and Multiple Fly-bys.
- CLUSTER - Study of small-scale space plasma processes using a cluster of four spacecraft.
- SOHO -Solar Observatory (Interior, Corona and Heliosphere).

Other scientific programs being given consideration for potential collaboration with the United States include:

- RADIO ASTRONOMY
  QUASAT--VLBI radio astronomy observatory in space plus world-wide distribution of ground-based radio telescopes.
- ULTRAVIOLET ASTRONOMY
  FUSE/MAGELLAN--a spectroscopy mission in the wavelengths inaccessible to the Advanced X-ray Astronomy Facility and the Space Telescope.
- PLANETARY EXPLORATION
  A variety of missions under study by Joint Working Group of European Science Foundation (ESF) and U.S. National Academy of Sciences (NAS).

Questions and Answers

U.S. Delegation: Who are the major prime contractors for ESA programs?
ESA: The major prime contractors for ESA programs are: Dornier, MBB/ERNO, Aerospatiale, and British Aerospace.
U.S. Delegation: What are ESA's views on the commercialization of land and weather satellites by the United States?
ESA: There already exists a commercial arrangement regarding use of Landsat data whereby ESA pays an annual fee per Landsat ground station. If commercialization of Landsat resulted in significant increases in the cost of data and the Landsat ground station annual fees, this could be a problem. There has also been some discussion between NOAA and ESA regarding Europe's participation in the United States polar orbiting weather satellite system.
U.S. Delegation: Is there popular support in Europe for space activities?
ESA: Yes, with the strongest popular support probably in France.
U.S. Delegation: What is the involvement, if any, of ESA in European military space activities?
ESA: ESA's charter provides for involvement in only civilian and peaceful space programs and for no involvement in military programs.
U.S. Delegation: In addition to future cooperative science programs, what are ESA's views on long-range space programs?
ESA: In the near term ESA is studying increasing the performance of Ariane as well as development of a free-flying platform, EURECA, utilizing Spacelab related hardware. There is more uncertainty with 1987 and beyond. The major questions include: Does the geostationary orbit continue to dominate commercial activities? What is the future for materials processing in space in low earth orbit? What is the role of man? Certainly ESA is interested in how the agency might participate in a Space Station program, should the United States decide to proceed. ESA is looking at candidate hardware elements for a coperative space station program.

INTERNATIONAL ENERGY AGENCY (IEA)

Location: Paris, France
Date of Visit: May 30, 1983

SUMMARY

The delegation met with Dr. Eric Willis, Research Director of the International Energy Agency (IEA) and Mr. Tom Wajda of the Organization for Economic Cooperation and Development (OECD) to discuss the status of the R&D activities pursued or reviewed by the IEA.

Background

After the embargo of 1973, the United States and 18 other members of the Organization of Economic Cooperation and Development (OECD) (France is not a member of the IEA), recognized the need to unite in a coordinated effort to decrease dependence on imported oil. In order to reduce strategic and economic vulnerability, the participating nations decided to set up cooperative R&D programs and to create a system for allocating imports in time of emergency. The percentage allocated is to be based on consumption prior to the cut-off. Although the IEA considers emergency questions, it is also concerned with supply projections for all non-nuclear fuels, long-term cooperation in energy R&D and the status of relations with producer and other consumer countries.

The basic goal of the IEA is to organize and influence economic policies. Matters of a technical nature in the nuclear area are reserved for the Nuclear Energy Agency. In other areas, the IEA has assisted in the creation of mechanisms for work between countries on coal and solar energy, but prefers not to be actually directly responsible for any hardware development.

DISCUSSION

Since the last time the Committee met with IEA officials the world oil price has decreased substantially, and the effects of the recession being experienced by Member countries has grown more serious. The French, who are not in IEA, have been pressing forward with a strong nuclear program, but beginning to be more concerned about the excess of electric capacity since the demand for energy is less than was anticipated.

In addition, the relatively cheap cost of natural gas coming in from off shore, has caused a reduction in the expansion of conservation measures, including heat pumps and co-generation. The IEA has recently issued reports on heat pumps, coal liquefaction, and co-generation.

The enormous cost of continuing energy programs with a long payoff such as fusion was discussed. Dr. Willis indicated that there is some concern beginning to be raised about whether the large sums of money being spent by several of the members can be continued - and for that reason whether the future efforts can be better coordinated, so that the funds are used in a complementary manner.

Dr. Willis discussed six technological issues concerning energy research and development in member nations. His basic question is, "why do energy R&D at all?" First, he felt that putting coal and nuclear energy in

commercial use is a short-term issue. Secondly, long-term R&D includes the advancement of such areas as breeder reactors and fusion energy, which were recognized as being far from maturity. The third issue is building a technology base in basic sciences, such as coal combustion. The fourth area of concern is to carry out R&D for improving the efficiencies of energy production and end-use. Fifth, Willis believes that investments should be continued in renewable energy and areas such as geothermal which have local application. Finally, he included supporting technologies such as electric power transmission and storage.

However, these technological issues should be considered in light of other influencing factors. He mentioned the impact of politics, geography, climate, and economics, particularly, recession/inflation cycles, interest rates and rate of return on investments.

A 1982 paper, "Funding for Energy Research in Six IEA Countries", follows:

Funding for energy research in six IEA countries

Dr Eric H Willis

Energy research, development and demonstration (RD&D) budgets for six International Energy Agency countries show that coal, gas and nuclear power will be the main substitutes for oil to meet the energy demand of AD 2000, with conservation playing its part. In the long term, however, RD&D will reflect the need to substitute nuclear power for fossil fuels, according to the IEA's Director of Research.

In 1973, as a result of the Arab oil embargo, it dawned upon a relatively unsuspecting world that alternatives to oil should be found without delay to make our economies, if not secure then, less vulnerable to future oil crises. This sense of urgency was made greater by the commonly held belief that the inevitable diminution in fossil fuel supplies would cast its shadow over the industrialised world as early as 1990. With this sense of urgency, IEA governments set about the creation of an energy research, development and demonstration (RD&D) effort which now invests some $8.5 billion a year. Of this sum, 92 per cent was expended by six of the seven countries participating in the Economic Summit – Canada, Germany, Italy, Japan, the UK and the United States*. This article examines the course of this very large investment over the years 1976 to 1982 in these countries, specifically the support given in each country to various technology areas by governments and, where available, by industry.

While 1980 saw a continuation of fairly liberal investment in energy RD&D in the public sector in 1981 governments were seeking a clearer understanding of which technology options should be more vigorously pursued, and what mechanisms would be the most effective for achieving the goals of demonstration and early commercialisation. At the same time recessionary forces, combined with high interest rates, ensured that in most countries more rigorous economic criteria were adopted in relation to investment in energy technology development. This was compounded later in the year by new perceptions of the short-to-medium-term oil market, resulting in more relaxed attitudes, both in regard to price and supply. In addition long term price projections were also revised downwards to show a relatively slow long term growth, in contrast to the projections of previous years.

Basic philosophical differences involving the role of governments *vis-à-vis*

*The seventh country in the Economic Summit, France, is not a member of the International Energy Agency, and comparable budget figures are consequently not available.

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industry developed between countries, exposing some fundamental differences between national energy R&D policies which are, to some extent, reflected in the budget figures discussed below.

Overall budgets

The figures for total budgets for IEA governments energy RD&D expenditures in 1981 US dollars for the years 1977-81 are 6.2 billion (an increase of 14 per cent), 7.1 billion (11 per cent increase), 7.8 billion (6 per cent increase), 8.3 billion and 8.5 billion (the increase between 1980 and 1981 was a minimal 2 per cent).

Actual country performance varies to a considerable degree. Some countries, Canada, Germany and the UK, have had relatively level government energy RD&D budgets over the past four years with perhaps a general tendency towards modest percentage increases. Italy started with a relatively lower budget base level, and the consequent percentage increase appears correspondingly large.

Two large economies have reacted in a different manner to government energy RD&D investments. Japan has always placed high significance on government funded energy research as a stimulus to industry, as befits a country with few indigenous natural energy resources. This investment was markedly increased after the 1979 oil price shock, when oil tax revenues and an electricity consumption tax were used in part to finance energy RD&D. These two taxes contributed the annual equivalent of US$800m for energy-related purposes, and this is reflected in part in the budget increases of 1979, 1980 and 1981. The National Energy Development Organisation (NEDO) was created in 1980 to administer the increased emphasis on energy RD&D, especially as some technologies approached the much more costly demonstration phase prior to their eventual commercialisation.

In the United States, much more richly endowed with domestic energy resources than Japan, the reaction was initially somewhat similar but latterly has become noticeably different. Large real increases in overall budgets of the order of 15 per cent a year took place between 1977, 1978 and 1979 but fell away slightly in 1980. With the advent of the new US Administration, the 1981 budget started to fall, but the extent of the fall will only be measured when seen against 1982 figures and 1983 projections. These show declines of 23 per cent and 53 per cent respectively (with respect to 1981) so that the 1980-81 decline appears real and continuous. Indeed it reflects the now well known policy of allowing the unfettered energy price mechanisms to establish investment priorities, including energy RD&D, in the free market place and to reserve government involvement for those long term, high risk, high pay-off ventures which industry could not be expected to undertake.

RD&D investment by technology area

The trends in energy RD&D budgets among Member countries are shown on pages 4 and 5 in Tables I to VI over a six-year period in constant 1981 US

dollars with inflation indices and exchange rate fluctuations factored in. In spite of the inaccuracies and distortions inherent in such an analysis, the overall picture reflects quite clearly some interesting policy developments in national RD&D policies.

Conservation technologies (Table I)

Oil consumption by the OECD countries has declined to 91 per cent of the 1973 use despite a rise of over 25 per cent in the total gross domestic product. The decrease in oil use registered from 1980 to 1981 alone was already 6.3 per cent. The consequent dramatic lowering of the oil imports by IEA countries can be ascribed to a combination of factors: stock draw down of uncertain dimensions, the recessionary effect on economies, favourable weather conditions, and, of course, the conscious decision to use energy more efficiently. However, attitudes towards government involvement in RD&D in conservation technology vary considerably among IEA countries, some obviously concluding that the energy price signal is itself enough to trigger the requisite private investment. Others appear to reflect the view that without significant government initiatives in this sector, market penetration will not achieve the desired level to minimise national oil import objectives.

Japanese experience tends to be heavily in the direction of private sector involvement. After 1978, direct government investment about halved while industrial RD&D in 1979 reached ten times the government level. It should be noted that conservation is the only technical area to decline in an otherwise increasing national Japanese energy RD&D budget.

The United States engaged in a vigorous programme in conservation, rising to $319m in 1980. This has been followed, however, by a very sharp drop to $257m in 1981 and a projected $128m in 1982. The drop reflects a major policy shift towards the responsibility for conservation research being given to the private sector. In this regard, the policies of Japan and the United States now appear to coincide, although the US expenditures continue to be higher in absolute terms.

Germany shows a contrary trend to Japan and the United States with more than a doubling of the government effort since 1978. Other countries placing increasing emphasis on government stimulations of conservation research include Australia, Canada, Denmark, Ireland, Italy, Sweden and Switzerland. Most of the remaining countries have maintained approximately level funding over the past three or four years in real terms. Whatever the policy, conservation research continues to be seen as making an immediate and collectively substantial contribution to the decline in oil demand.

Oil, gas and coal technologies (Tables II & III)

Oil, gas and coal have a large disparity in their industrial infrastructure which is reflected in the degree of government and industrial support given to research

Government and Industrial energy RD&D Budgets in millions 1981 US dollars[1] [2]
Six Economic Summit countries

Country	1976		1977		1978		1979		1980		1981		1982[3]
	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.
Table I – Conservation													
Canada	11.5	—	12.3	6.3	17.8	23.2	17.8	20.8	23.3	40.3	34.1	—	—
Germany	37.4	—	16.2	6.8	37.6	25.6	29.6	14.8	44.3	22.2	54.6	26.9	57.3
Italy	—	—	13.9	3.5	14.0	3.5	11.4	13.2	16.2	41.6	19.8	44.9	23.1
Japan	54.1	40.0	57.9	157.0	64.3	218.4	27.1	370.1	32.7	512.9	25.1	—	—
UK	30.2	—	27.1	—	29.3	20.4	26.6	19.4	25.8	21.7	27.9	20.0	—
USA	25.4	123.6	117.5	128.3	155.4	432.9	209.2	487.3	319.4	1046.4	224.7	1200.0	143.8
Table II – Oil and Gas													
Canada	18.9	—	33.4	86.8	47.4	97.3	46.7	99.4	35.1	122.6	37.4	—	—
Germany	6.5	—	7.3	4.7	10.0	6.5	6.3	3.3	9.7	4.8	20.4	10.2	45.3
Italy	—	—	0.1	15.9	0.1	19.2	0.1	33.2	0	39.2	0	33.8	0
Japan	0.8	7.8	0.7	35.6	2.0	50.8	22.2	87.7	65.9	154.0	73.3	—	—
UK	37.8	—	50.4	62.5	45.1	56.2	49.2	56.5	44.7	58.2	42.6	64.9	—
USA	40.4	567.3	90.5	589.2	114.9	449.8	109.8	338.7	124.3	752.1	87.0	740.0	53.1
Table III – Coal													
Canada	9.3	—	16.2	0.8	21.2	5.5	16.6	5.0	13.5	2.7	17.2	—	—
Germany	48.2	—	72.0	48.0	112.7	74.8	147.7	73.8	126.5	63.2	156.2	55.8	182.9
Italy	—	—	0.1	0.9	0.2	1.4	0.6	2.4	—	4.3	0.3	13.0	0
Japan	5.5	4.1	17.9	10.6	10.4	28.8	26.3	40.9	116.0	191.2	183.0	—	—
UK	1.9	—	6.9	81.7	13.7	116.1	19.1	120.6	8.1	142.9	9.0	138.9	—
USA	313.0	72.9	473.0	75.8	575.9	87.8	553.7	106.0	800.1	196.2	722.8	220.0	522.9

Country	1976		1977		1978		1979		1980		1981		1982(3)
	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.	Ind.	Govt.
Table IV – Conventional nuclear													
Canada	116.4	—	106.2	8.2	121.7	18.3	109.8	—	106.8	18.3	107.9	—	—
Germany	334.1	28.7	364.7	80.9	371.4	56.7	400.9	63.3	401.1	64.4	423.4	48.7	420.0
Italy	—	—	82.7	11.3	93.8	16.0	138.8	14.6	161.3	17.0	242.8	18.0	247.2
Japan	248.9	137.0	456.2	215.2	524.2	162.0	586.2	161.4	700.1	172.6	722.7	—	—
UK	184.9	—	164.7	49.8	106.1	54.9	107.9	58.5	122.6	58.5	140.5	54.8	—
USA	304.5	240.4	488.6	238.3	546.7	88.7	578.9	94.1	450.2	239.8	531.4	220.0	525.7
Table V – Advanced nuclear													
Canada	3.1	—	3.9	0	4.5	0	4.2	0	5.7	0	8.3	0	—
Germany	209.0	—	212.3	13.6	174.4	6.0	173.9	10.1	187.9	12.0	210.4	33.3	212.4
Italy	—	—	105.1	1.0	96.5	1.8	125.6	2.9	101.5	3.9	232.5	8.7	247.9
Japan	120.8	7.2	163.2	9.3	187.1	11.8	260.8	14.2	359.5	13.2	401.9	—	—
UK	232.5	—	157.8	—	275.0	9.3	242.4	8.7	240.6	4.8	213.1	4.1	—
USA	1036.4	9.7	1336.3	10.1	1381.1	30.7	1480.8	36.0	1196.8	8.7	1004.9	12.0	1101.2
Table VI – Renewables													
Canada	4.8	—	12.3	7.4	29.3	6.2	32.6	5.1	33.8	5.7	52.5	—	—
Germany	10.4	—	15.7	10.4	26.6	17.1	58.1	29.1	60.9	39.7	47.9	44.1	63.9
Italy	—	—	3.9	10.7	8.3	17.8	8.1	28.0	15.4	37.5	26.7	38.4	31.1
Japan	24.0	23.6	24.2	27.6	30.2	33.0	38.9	65.7	94.6	114.5	102.3	—	—
UK	2.6	—	5.3	—	15.0	1.4	26.2	1.4	23.3	1.1	30.6	1.4	—
USA	134.7	34.6	331.1	36.4	496.3	25.1	672.3	42.6	734.7	981.0	663.7	1300.0	276.3

(1) GNP/GDP deflators from *OECD Economic Outlook* used to calculate values at 1981 prices.
(2) Exchange rates taken from *IMF International Financial Statistics*.
(3) Estimated by governments and subject to revision.

in the three areas. Oil, by virtue of its exploration, exploitation, transportation, refining and distribution infrastructures, has tended to aggregate around large corporate enterprises, whether privately or government-owned, and operated in worldwide context. Gas, until recently has been relatively regional, but is becoming open to more widespread use through new long distance pipe lines and liquefied natural gas transportation by sea. Coal has been more of a distributed industry in most countries except the UK, with a wider spectrum of product characteristics than with oil and certainly with gas. The advent of oil and gas to widespread use has, until recently, relegated coal to a lower acceptance level on account of its perceived poorer environmental image coupled with more arduous transportation and handling properties. These considerations appear to have influenced governments in their decisions to invest in different ways for research in these three areas, and Tables II and III reflect these decisions in budgetary terms.

Oil and gas

Research in all three fossil fuels are, in general, only supported significantly by countries with indigenous supplies of these fuels, with the conspicuous exception of Japan. However, it is very evident that, in producer countries and some consumer countries alike, *oil* oriented research in particular is considered primarily the responsibility of the industry whose corporate funding, vested interest and well-developed decision-making capacity is, in general, able to pursue this avenue of research with the appropriate vigour. Since 1979, however, Japan has invested considerable government funding in oil and gas research, rising from $22.7m in 1979 to $73.2m in 1981. Canada, with major oil and gas interests, has decreased its research government investment in these areas as its industrial contribution appears to have risen. This is also true of the United States although, unlike other energy technologies, the governmental involvement did not rise to the large peaks in 1978, 1979 and 1980 associated with other technologies. The UK has maintained a substantial but slightly declining effort from 1977 onwards. Australia, a potentially major coal producer, has increased its research effort considerably from $13.7m in 1979 to $18.1m in 1981. Australia's industrial sector effort has increased somewhat faster, to $26.1m in 1981, and is in fact the only instance reported where the industrial contribution in 1981 exceeds that of its government.

Coal

Coal oriented research, however, shows a different pattern due perhaps in part to the difference in infrastructure referred to earlier. Coal reporting figures from industry are generally not well documented, possibly due to the more fragmented nature of the coal industry in many countries as distinct from the more centralised oil industry, where the ability to aggregate data, again with the UK

apart, is greatly enhanced. Germany has sustained a high level of coal research over the past four years, at about $120m a year, which continues a long tradition in this field. Japan accelerated its effort dramatically from $10.4m in 1978 to $26.3m in 1979, $116m in 1980 and $183m in 1981. By any measurement, this degree of rise is of great significance. It illustrates not only a deep commitment to coal oriented research but particularly to the development and demonstration associated with production of liquids and gas from coal. 1981 would appear, however, to be a major turning point in the US Government's direct support for coal liquefaction and gasification, although attempts are being made to further development, and ultimately commercialisation in the private sector through the mechanism of the Synthetic Fuels Corporation. This essentially recognises the commercial risks being asked of the industry in this costly development, by underwriting some of the risk through loan guarantees. Direct US government involvement seems destined for further reductions by the projections of £522.9m for 1982, and budget requests of a little more than $100m for 1983. Canada has maintained a fairly constant level of between $15m and $20m since 1977.

Nuclear technologies (Tables IV & V)

The nuclear industry *per se* is confined to a limited number of countries, and the technology is employs is basically derived from national government sponsorship. Unlike other facets of the energy industry, the nuclear industry is a child of government. Thus it may come as little surprise that in 1981, nuclear research, that is, conventional nuclear non-breeder technology, other advanced non-breeder converters, the nuclear fuel cycle, nuclear supporting technology, breeder reactors and fusion energy experiments accounted for $4450m, or 53.5 per cent of the total IEA Member countries' investment in energy RD&D. This is a formidable sum, and appears to reflect a widely held feeling that nuclear energy, in one or other of its forms, represents the only *new* technology capable of making a substantial contribution to the energy supply balance early in the next century, and the only one ultimately to replace fossil fuels combustion of one form or another.

Table IV shows that while the US, the UK, Canada and Germany have maintained a high but steady level of conventional nuclear funding of about $500m, $130m, $110m and $375m respectively, Japanese investment since 1976 has risen from $248.9m to $722.7m, making Japan by far the largest investor in this area.

However, Italy has recently increased its expenditures very significantly from $82.7m in 1977 to $242.8m in 1981.

Thus while considerable sums are still devoted to improving present generation equipment and research into other types of converter, such as high temperature gas reactors and other concepts, the bulk of non-breeder nuclear RD&D goes into nuclear fuel cycle and supporting technologies. This probably

reflects the drive to find a publicly acceptable way to handle the non-proliferation, nuclear waste repositories, nuclear safety and other issues which have aroused contention and slowing down of the installation of nuclear electricity generating capacity in IEA countries. This 'prophylactic' type RD&D accounts for some $1342m in those six countries, and over 70 per cent of the $2254m expended on conventional nuclear research in all IEA countries. This constitutes a strong commitment to the future of nuclear produced electricity in IEA countries generally, although in some countries this commitment has been tempered by referenda and legislation inspired by environmental concerns.

Under the heading of advanced nuclear technology, there are two components: breeder reactors and fusion energy. In 1981, breeder technology accounted for $1545m expenditures among IEA countries and fusion for about $720m.

The United States breeder programme has had a chequered career with policy reversals connected with the Clinch River Project, but the fast flux test reactor at Hanford has meanwhile continued a successful course. The US expenditure on breeder technology was $688.5m in 1981, and represents a major commitment. The Japanese programme is increasing steadily with $236.8m in 1981, and Italy has a comparable programme with a sharp increase in 1981 to $204.2m, or 38.8 per cent of the total Italian energy RD&D budget. The main thrust of this programme is a participation in the French Phénix and Superphénix breeder programmes; in addition a small experimental reactor (PEC) is under construction. Germany, in co-operation with the Netherlands and Belgium ($166.8m, $35m and $26.1m respectively), is pursuing a breeder programme centred on the Kalkar reactor, and is also participating in the French breeder reactor demonstration programme. The UK ($182.6m) continues its breeder development at the Dounreay facility.

These represent the major facilities for breeder technology within the IEA group of countries for a total of 18.2 per cent of the total IEA country energy RD&D expenditures. It is a remarkable commitment to the future of nuclear energy and again reflects the belief that no alternative technology can currently hold the same ultimate potential.

Fusion energy would, however, in principle provide a comparable return on investment to the breeder, but it is far from the development stage that the breeder is today. The problem with fusion energy has been, and will continue to be for some years, how to sustain high annual levels of investments in the face of results which, however dramatic in their way, are not remotely yet at a stage at which power output can be achieved. Nevertheless, the fusion programmes continue to attract substantial support. The United States spent $443.7m and Japan $165.1m in 1981. Members of the European Community have significant programmes, both collectively and individually. Germany ($44.0m), Italy ($28.3m), the UK ($30.6m) and the Netherlands ($9.3m) have major programmes.

The way ahead for fusion energy will entail very costly developments of a nature and risk level which individual countries will find it hard to meet from

their own resources. International co-operation in this field is thus likely to grow in importance in future years.

Renewable energy technologies (Table VI)

The 1970s saw a marked rise in support for renewable energy technology research, particularly in the United States, whose budget in this area reached a peak of $734.7m in 1980, a sixfold rise from 1976. At the same time US industry involvement, after a hesitant start, appears to have surpassed one billion dollars in 1981. The precipitous decline projected for 1982 in the US funding for renewable energy has been variously interpreted, but it is clear that despite its fall from very generous support, it remains a substantial programme, comparable to that of Japan ($102.3m in 1981). It remains to be seen in 1983 whether the downward trend continues and how selective the cuts prove to be. Certainly industry is investing heavily at the present time and it could be argued with some truth that previous US government programmes have provided industry with its present ability to expand. Nevertheless, it is unlikely that renewable energy sources, excluding hydro and firewood, will account for more than 1.5 per cent of the total energy supply by the year 2000. It is however likely to be most significant regionally.

Among the other countries within the IEA nine continue to increase their support for renewable energy, while the remainder appear to have reached a plateau. Ireland spends 56 per cent of its total $7.1m energy RD&D funding on renewable energy, mostly on wind and biomass. Austria, Denmark, Greece, New Zealand, and Spain all devote greater than 20 per cent of their total budgets to renewables and Sweden devotes nearly 35 per cent.

Conclusions

Nine years after the Arab oil embargo of 1973, energy research is becoming much more focused as each country sees more clearly its priorities and where its funds promise the greater return on investment. In the short to mid term there has been a growing realisation that coal, gas and nuclear, together with continued efforts towards conservation, will continue to be the principal substitutes for oil to meet the energy supply/demand balance of the year 2000. Should these fuels not be allowed to make their full contribution, present projections will fall short with possibly serious consequences. Much research effort is being employed to prevent such an occurrence. Despite these urgent short term considerations, it is important to stress once again that energy research and development remains inherently a long term endeavour driven by the need for fundamental change to substitute for fossil fuels in the decades ahead.

N.B.: The figures and information in this article are abstracted from *Energy Research, Development and Demonstration in the IEA Countries – 1981 Review of National Programmes.*

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ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

Location: 19 Rue de Franqueville 16, Paris, France
Date: Monday, May 30, 1983

REPORT

Mr. Yvan Fabian, Head of the Science and Technology Research and Development Unit of OECD and staff were visited by members of the Congressional delegation. Mr. Andrew Reynolds, DOE representative to the U.S. Mission at OECD also attended the meeting.

OECD publishes a series of documents entitled, SCIENCE AND TECHNOLOGY INDICATORS which contain data on international research and development activities of interest to the Committee. The meeting opened lines of communications with OECD to learn how their data were accumulated and to clarify definition of the various outputs.

Several supporting documents were received, Transportation, Aviation and Materials Subcommittee staff were put on the OECD distribution list, and their data acquisition questionnaires were examined to determine if TAM needs could be fulfilled by the OECD program.

The committe delegation was interested in understanding the level and direction of effort of other industrial nations on a common basis of measurement. OECD is one valuable source for this information and a good interface was established by this meeting. Such information will better enable the committee to assess areas of need for U.S. aeronautical R&D.

TRAIN 'A GRANDE VITESSE (TGV)

Location: Paris to Lyon, France
Date: May 30, 1983

SUMMARY

Members of the Committee delegation took the TGV from Paris to Lyon and back to experience and learn about the fast, state-of-the-art rail service available to rail travelers.

DISCUSSION

Since September, 1981, the French National Railways has been running a fleet of 160-mile-an-hour TGV's (train 'a grande vitesse) in the country's most heavily traveled rail corridor--the Paris-Southeast France section.

Fast, quiet, comfortable and convenient, these trains are highly popular with French travelers. Based on the impressions of Committee Representatives who rode one of the regularly scheduled TGV trains 300 miles to Lyon and back, it is easy to understand why.

A traveler may choose from among 18 departures a day from Paris to Lyon. The ride is quiet and smooth--a far cry from the trains and rail bed familiar to passengers on the fastest trains in the Washington-Boston-Northeast Corridor.

The speedy, comfortable ride is a product of 20 years of testing and experimentation by the French National Railways and French industry. The TGV runs on a new, continuous standard-gauge track designed exclusively for passenger traffic. Each TGV train consists of two power cars and eight coaches with a capacity of 386 passengers. An articulated design allows each two cars to share a common wheel truck between them.

Ordinary rail cars have trucks at either end. With one truck instead of two where the cars connect, the TGV coaches are lighter and have lower rolling resistance. This also reduces the electric power needed to drive the 4,000-horsepower engines. Authorities say that when fuel costs are computed, a TGV passenger may be carried for only one-seventh of the cost for carrying a passenger aboard the French-built transport plane, the Airbus.

Interiors of the TGV coaches are clean and comfortable, with seats similar to those in aircraft. Food and beverage service is available at one's seat or in the bar car.

Surely the TGV's biggest advantage, of course, is its speed. Even though not all sections of the new tracks between Paris and Lyon have been completed and the trains must use some parts of existing tracks, the TGV nevertheless whisks passengers through the French countryside at impressive speed. The route was carefully designed to avoid populated areas. There are no level crossings. On some farms, grazing cattle have their own tunnels to go under the track.

On the trip taken by Committee Representatives, the TGV adhered strictly to its schedule departure and arrival times, taking two hours and

36 minutes to traverse the approximately 300 miles between Paris and Lyon. The engineer announced at one point that our speed was 131 miles an hour. Even more time can be shaved from the schedules when the entire new Paris-Lyon track is completed later this year.

Developed and built at a reported cost of $1.6 million from the French Government, the TGV trains have been popular from the very beginning, especially with business travelers. In their first few months of service, the trains carried about 14,000 passengers a day, considerably above forecasted loads. By 1985, traffic on the Paris-Lyon line is expected to hit 22 million passengers a year, as compared with 12.6 million in 1975.

CERN - EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Location: Geneva, Switzerland.
Date: May 31, 1983.

SUMMARY

The delegation attended briefings and toured the CERN complex for high energy physics research. Following the tour additional discussions were held with: Dr. Herwig Schopper, CERN's Director-General; Dr. Erwin Gabathuler, CERN's Research Director; Dr. Carlo Rubbia of Harvard University and Dr. Samuel Ting of MIT, both of whom are U.S. physicists leading large international research teams using CERN accelerator facilities. The general purpose of the delegation visit was to compare the U.S. and CERN high energy physics programs and to explore the prospects for world-wide cooperation in the construction of the next generation of giant accelerator facilities.

DISCUSSION

Background

CERN is the research center for West European high energy physics research. Twelve member States share the cost of CERN operations and facility construction: Austria, Belgium, Denmark, France, West Germany, Greece, Italy, Netherlands, Norway, Sweden, Switzerland, and United Kingdom. In recent years, CERN has invested proportionally more than the U.S. in high energy physics, especially for construction of large, new accelerator facilities. CERN now has in operation the world's largest proton-antiproton colliding beam machines, the SPS, at which the latest key discoveries were made -- the detection of the so-called W and Z particles. Under construction at CERN is the world's largest electron-positron colliding beam machine (LEP), which is 27 kilometers in circumference.

The prime function of CERN is to provide the physicists of Europe with particle physics research facilities of world class, which could not be obtained with the resources of any individual country. This makes CERN the principal European center for fundamental research into the structure of matter.

The research at the CERN Laboratory is largely undertaken by teams of visiting scientists who remain based at their parent university or research center in Europe. Over 1500 physicists depend upon CERN for all or part of their research material. Visitors from over 600 different universities and institutes in member States and elsewhere have participated in the CERN experimental program.

In general the CERN staff is drawn from the member States but scientists of any country may be invited to spend a limited period at CERN. Many scientists from the U.S. work at the Laboratory. There is a formal agreement for collaboration with laboratories in the U.S.S.R.

Each member State pays a fixed contribution to the capital and operating costs of the CERN program according to a scale established every three years on the basis of the net national income figures for the previous three years supplied by the United Nations. No single State, however, can be required to pay a contribution in excess of 25% of the program.

The relevant percentage contributions to the budget were last fixed as follows:

Austria	2.53
Belgium	4.66
Denmark	2.49
France	21.70
Germany	25.00
Greece	0.36
Italy	12.73
Netherlands	6.18
Norway	1.79
Sweden	4.30
Switzerland	4.13
U.K.	14.13

CERN's budget in 1981 was 610 million Swiss francs (approximately $300 million), and it has been held essentially constant in 1982 and 1983.

Policies for New Facilities

The briefing focussed primarily on CERN's major construction project, the giant LEP facility, which is estimated to cost $500 million for the accelerator ring alone (not including the detectors). The first phase of LEP will be a 50 billion electron volt, electron-positron colliding beam machine, utilizing conventional magnet technology. The first beam is due to be operating by the second half of 1988.

The second phase of LEP will upgrade the facility to 100 billion electron volts using the same magnets, but requiring the development of superconducting radio frequency cavities and very high power klystrons.

CERN policy is to hold its overall budget constant in real terms at about $300 million per annum. Thus, construction and startup of LEP requires shutting down some current facilities, such as the Intersecting Storage Rings (ISR) and selected research activities, such as lower priority, fixed target experiments. In this respect CERN plans to phase out activities in which the U.S. now or in the near future is expected to excell. CERN is also exploring future options, not yet approved, for using the LEP tunnels for additional rings to provide proton-electron and proton-antiproton colliding beam capabilities. The U.S. high energy physics community is now proposing similar super high energy facilities. It is clear that the U.S. program, managed by the Department of Energy (DOE), will need to coordinate its facility planning closely with CERN to avoid costly duplication.

Recent Discoveries at CERN

Researchers at CERN announced to the delegation that they have found the second of three particles needed to verify the unified theory of weak (nuclear decay) and electromagnetic forces. The particle is called the Z^0. Several months ago they discovered the W particle. The research team is headed by Carlo Rubbia of CERN and Harvard University.

The W and Z^0 particles are created when protons and antiprotons collide head on in CERN's SPS accelerator, which for the moment is the only machine in the world capable of this kind of experiment.

The delegation toured the SPS control room and was shown a video data display of collision events yielding the Z^0. The delegation then visited the SPS UA1 detector building to see the large installation required for

detecting the W and Z^0 events. The delegation also toured the shop where fabrication is underway on the high efficiency microwave cavities and klystrons for LEP.

Issues for the U.S. High Energy Physics Program

Dr. Schopper pointed out that the U.S. high energy physics program is meeting the CERN challenge with new, more powerful colliding beam facilities now under construction or proposed for construction at the three DOE research centers: Fermilab, Brookhaven and Stanford Linear Accelerator Center (SLAC). He emphasized that the new U.S. facilities that will come on-line in the next several years, Tevatron I and II, the Stanford Linear Collider, and the Colliding Beam Accelerator (tentative), will all be complementary to, rather than duplicative of, CERN's facilities.

The U.S. will also be directly involved in the construction and operation of one of the four large LEP detectors. This detector will cost $50 million, about half of which will be contributed by the DOE high energy physics program. The detector has been designed by U.S. Nobel Laureate, Dr. Samuel Ting of MIT, who will lead the large research team using the detector when LEP goes into operation.

The delegation had a broad ranging discussion on the future of high energy physics research with Dr. Schopper, Dr. Rubbia and Dr. Ting.

A significant issue for continuing Committee oversight involves the increasingly expensive accelerator programs of the U.S. and CERN and the need for greater international cooperation in facility planning, construction and operation.